Laurieston Hall is a community in South West Scotland which occasionally runs courses in building wood stoves, and also manufactures them under the name of Clachan Woodstoves.

Printed and Published by Lifespan Community Collective Ltd, 1980

Other titles:
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- Wholefood Recipes
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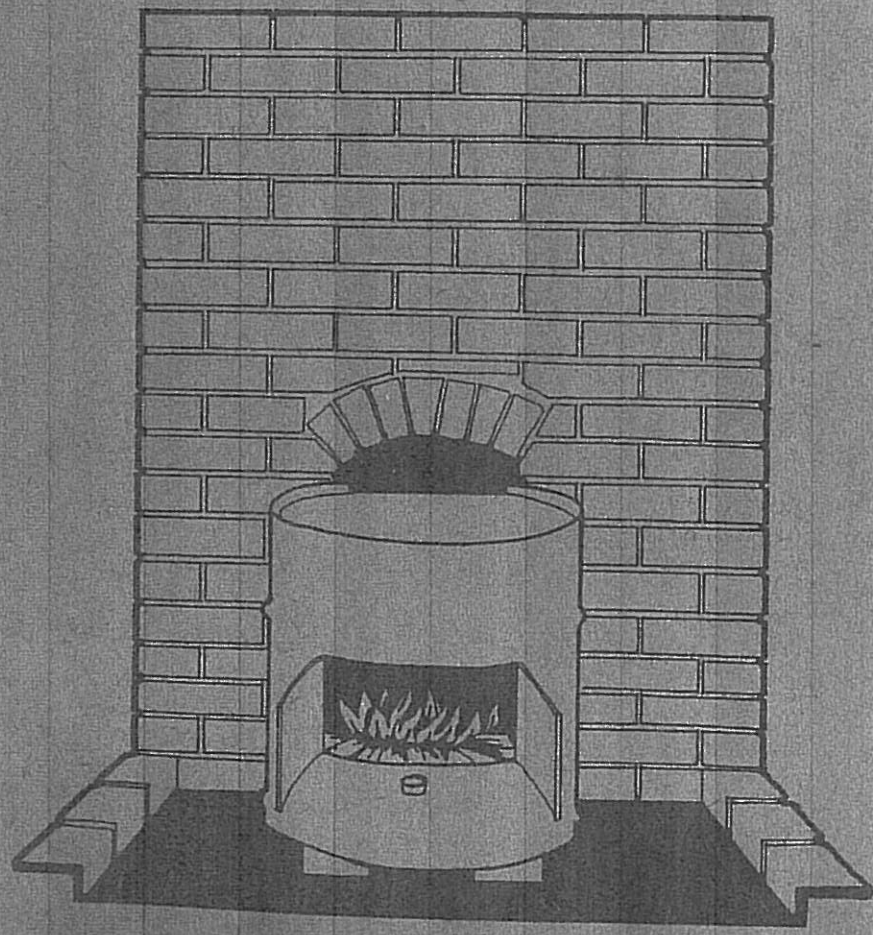
BUILDING WOODSTOVES



Contents

About This Book

This booklet sets out to demystify the design of wood stoves with examples of how they can be constructed in a home workshop out of readily available materials like churns, oil drums, water tanks or sheet steel. All the examples illustrated are in use at Laurieston Hall where they were built; some of them have several different versions.

The first sections explain how a stove works and show various ways of constructing the basic parts. Detailed instructions follow for building box stoves, open fires and combination stoves which can either function as a stove or open up as a fireplace. The last sections cover basic metal working techniques, and other possibilities for stove design.

Before starting work on a stove, it is a good idea to build a cardboard scale model and decide exactly how it will be installed.

How Wood Burns

Wood burns in three phases: first the water is heated to 212^{o} and evaporated as steam, taking a significant amount of heat up the chimney. The wood is then broken down into carboniferous gases and charcoal. Half the potential heat of the log is in these gases, which either burn as flames or disappear up the chimney as smoke. Finally, the charcoal itself is consumed, burning without flame and taking all the oxygen it can get, sometimes so greedily that it produces carbon monoxide instead of carbon dioxide, at half the heat output. These phases occur simultaneously in a fire as individual pieces of wood are in different stages of burning.

Burning green or wet wood is like throwing a cup of cold water on the fire for every log you put on. In the process of seasoning, water trapped biologically in the living cells is released, which can be a long process. The fibres of wood left lying in wet conditions soak up water like a sponge, but this will soon dry out.

The object in designing an efficient stove is to burn as much as possible of the smoke, and to distribute the heat into the room. To ignite, the gases will have to be well mixed with about four times their volume of air, so that the resulting fuel/air mixture is around 1000^{o}F. Furthermore, the charcoal will consume all the oxygen it can get, so the smoke must meet the incoming air between leaving the charcoal burning zone and reaching the flue. (For a detailed account of this process see chapter four of "The Woodburner's Encyclopaedia" published by Vermont Crossroads Press.)

Parts of a Stove

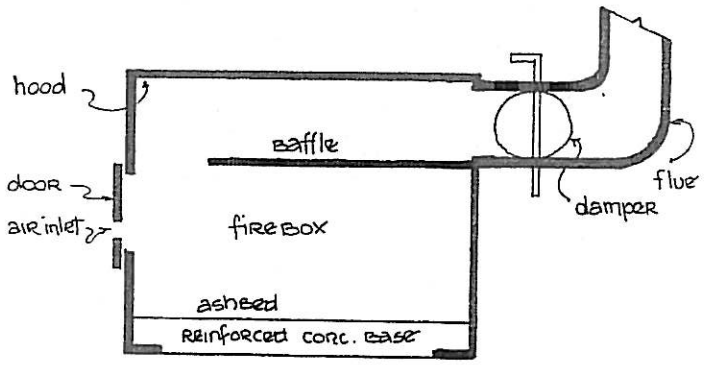


fig. 1 BOX stove

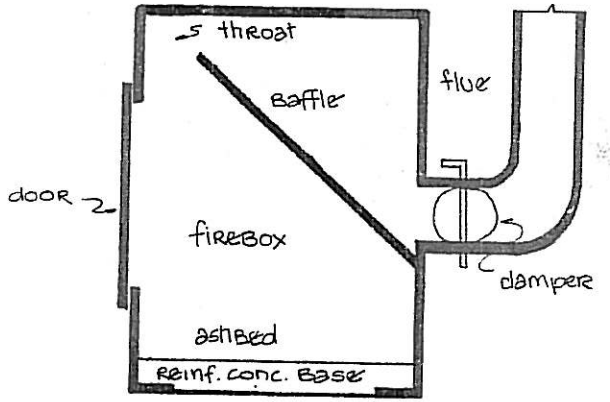


fig. 2 open fire OR combination stove

Grates

Some stoves, particularly those designed to burn any solid fuel, have a grate with an ash pan underneath, and an ash door. These are unnecessary in a wood stove, since wood produces very little ash, and burns better on a solid hearth.

Baffles

The crudest stoves often have no baffles at all, so that the smoke is not drawn towards the air inlet, and disappears unburned up the chimney. Others have a number of baffles, forcing the smoke on a longer path to the flue, and creating a great deal of turbulence to mix it with the incoming air.

Damper

The rate at which air will be drawn into the fire depends on the strength of the draw through the flue, and the size of the air inlets. A damper partially closes the flue, reducing its draw. Stoves with very simple doors that do not make an airtight seal when closed, or which are crudely jointed together so that air can leak through the seams, need a flue damper to slow down combustion. Many airtight stoves do not have any damper at all, and are entirely regulated by controlling the air supply.

Air Inlets

Some stoves have separate air supplies for burning the charcoal and the gases, generally referred to as primary and secondary air inlets. The secondary air may pass through a heated chamber or be piped right through the hottest part of the fire so that it does not cool the fuel gases below their ignition temperature, though it is unlikely that this temperature increase is sufficient to make any appreciable difference. It is more important that the secondary air is well distributed through the flames, with plenty of turbulence to mix the air with the burning smoke.

Flue

The flue is an essential part of the stove. Part of the flue may be an existing chimney or a specially installed flue pipe. If the flue is not sealed, the draw will be reduced, the temperature of the smoke will fall causing more deposits in the chimney, and warm air from the room will be sucked out. In the worst cases, smoke will billow out of the stove when the doors are opened, or even through the leaks.

Ideally the smoke should leave the top of the chimney at between 300°F and 800°F. Below 300°F too much condensation of wood tar, water and unburned particles will occur, increasing the danger of a chimney fire and blocking the flue. Above 800°F too much heat is wasted.

Any stove with an efficient baffle system, or that is turned down to burn slowly for long periods, will need a well insulated flue. This may be a brick chimney, or a double-walled metal pipe with insulation between the two walls. This is sometimes known as "Metal asbestos" pipe. It is not a good idea to expose a long length of cast iron flue pipe to extract the maximum heat from the flue, except with the crudest stoves burning very hot.

Door Details

All stoves have a fuel door, and to a large extent the details of them are interchangeable. Although the air inlet could be elsewhere, it is often convenient to have it in the door.

Position of the Door

The door opening should be high enough above the ashbed to prevent ash and hot charcoals falling out. If the hood – the part between the top of the door opening and the top of the stove – is too short, smoke may puff out into the room when the door is left open. The wider the door opening, the more likely this is. For a stove on which the door is normally left closed, 4 or 5 inches is usually enough, depending on the size of the door, but the hood should come down at least as far as the top of the baffle. On an open stove with large doors, 7 or 8 inches may be necessary.

Door Seals

The idea is to find the simplest way of closing a door so that little or no air leaks around its edges.

The simplest door is a flat plate, hinged on one side, closing over a hole cut in the front of the stove. If the stove and the door are thick, say ¼ inch plate or even 1/8 inch, a crude door like this may be adequate. However, both the door and the metal surrounding the hole will tend to distort, so that neither is flat.

The hole can easily be strengthened by turning back flaps either at right angles to the opening or curving gently round further than that. The seal can be improved by a generous overlap of the door over the opening. An inch overlap is adequate. Distortion of the door can be reduced by bolting a box to the back.

This box can serve a second function, in separating the primary air that feeds the burning charcoal from the secondary air that burns the fuel gases. Ventilating the box like this also helps to keep the door cool. (For details of construction of the box, see "Air Inlet Controls")

For a combination stove which has large doors opening up to expose the fire, a box on the back of the door is rather heavy. One way round this is to design the stove with a curved front and fit curved doors. The curve allows the stove and door to expand without distortion. For simplicity, the combination stoves in this book have no special air inlet, relying on the air leaking around the door to keep them alight when closed down, and leaving the doors a little open to fire it up. This is because the stove will generally be used with the doors open when the room is in use, or closed down to keep alight and warm the room when there is no-one there, For finer control, they rely entirely on the damper.

A third possibility is a collared door that pulls off instead of opening on a hinge. The collar can give a good seal, though it is more inconvenient to use.

Air Inlet Controls

The heat output of a stove depends on the size of the air inlet, although beyond a certain point the extra air let in will go straight up the chimney instead of increasing the rate of combustion. The potential heat output is also proportional to the surface area of the stove. Ignore the surface area of the bottom of the stove for this purpose, and also the back if it is fitted flush up against the fireplace.

The table shows the heat output of a stove in relation to its surface area and the approximate size of air inlet. The last column shows the diameter (D) in inches of air inlet required, assuming a "hit and miss" air inlet as shown. (see fig 3)

Heat Output (Kilowatts)	Surface of Stove (sq. in.)	Size of Air Inlet (sq. in.)	Diameter of Air Inlet (D)
3	900	2½	2¾
4	1100	3	3
5	1430	4	3½
6	1700	4¾	3¾
7	2000	5½	4
8	2300	6¼	4¼

Make a control for such an air inlet at least ¼ inch larger than the holes in all directions. Here is one way to do it:

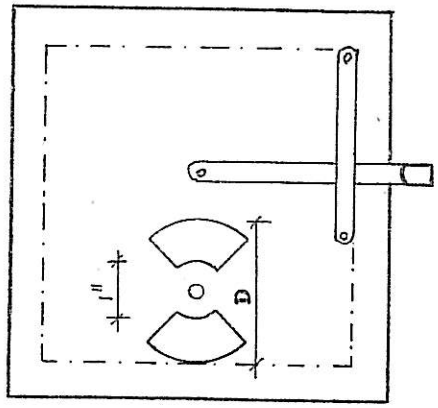


fig. 3

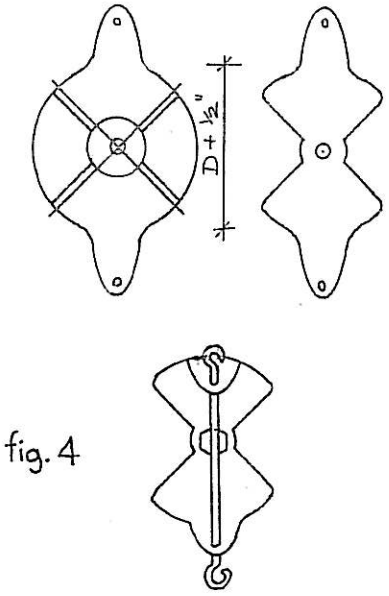


fig. 4

Cut a sheet metal disc at least ½ inch larger than the diameter of the air inlet, with 1¼ inch tabs top and bottom. Mark an inch diameter circle in the middle and divide it into quadrants as shown. Cut out two opposite quadrants; drill the centre to take a bolt and the tabs to take a bar. Bend up the tabs, fit the bar and twist the ends over into loops (heating with a blow torch makes it easier). Put a bolt in the centre hole before fitting the bar.

Bolt the air inlet control to the door with a spring to hold it tightly without making it stiff to adjust.

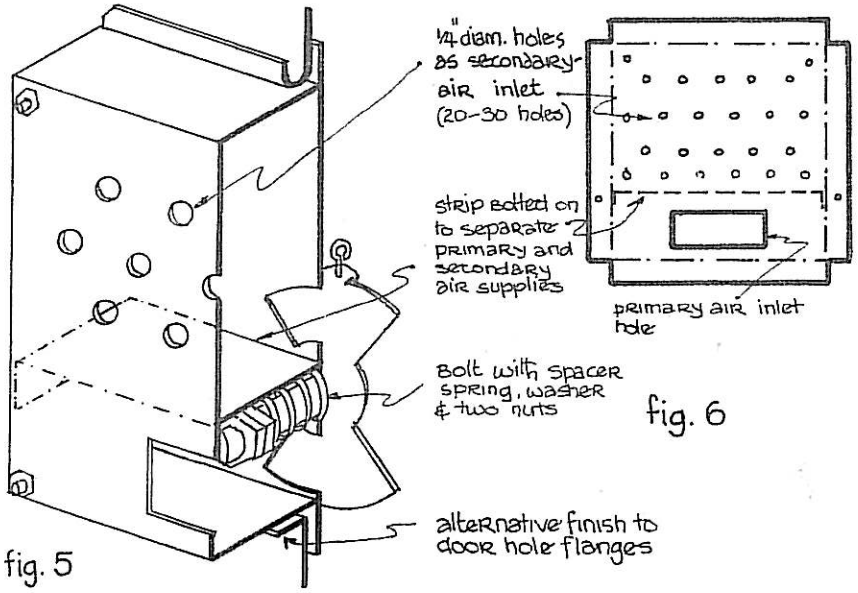


fig. 5

fig. 6

Make an inch-deep box to fit on the back of the door. It should be about an inch narrower and ½ inch shorter than the door opening so as not to jam against it when opened or closed. (see fig 6)

Fit a strip across inside the box to separate the primary air through the lower section of the air inlet from the secondary air through the upper hole. Rivet it to the sides of the box, or bolt it and grind the bolt heads down so they do not foul the door when it is opening.

Cut a hole near the bottom a little larger than the air inlet opposite it on the door. Drill several ¼ inch holes near the top of the box so that the secondary air enters over a broad area.

Bolt the box to the door, making sure the walls are all the same height so that bolting it on does not distort the door. The bolts should be as close to the corners of the box as possible.

Door Catches and Handles

The commonest type is a latch bolted to the door that drops behind a catch beside the door opening. A longer latch will move more easily, but a guide then becomes necessary to stop it bending. (see fig 7)

It will get uncomfortably hot, so it is worth bending the end over away from the stove, or extending it beyond the side wall. Better still, fit a ceramic handle. An eggcup with the bottom cut off and a hole drilled through is very effective.

The same type of latch works on double doors like those on the combination stoves described later. The latch is on one door and the catch on the other.

A short length of pipe of between 1 and 2 inches diameter can be cut into a ring for use as a handle. It can also be swivelled to make a simple door catch, trapping the door in the vertical position and leaving just enough clearance to miss it when horizontal. The ring will stay cooler if it is cut so that the heat can only travel round one way. (see fig 8)

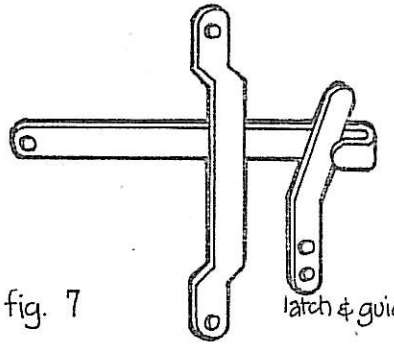


fig. 7

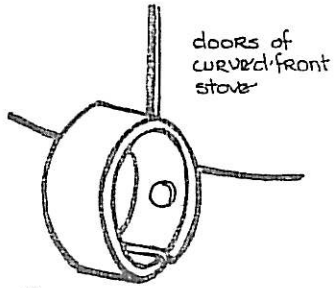


fig. 8 ring catch

Hinges

Ordinary butt hinges are useful. A strip is needed beneath the hinge to compensate for the thickness of the door, and also improves the seal. The two hinges must be in line with each other.

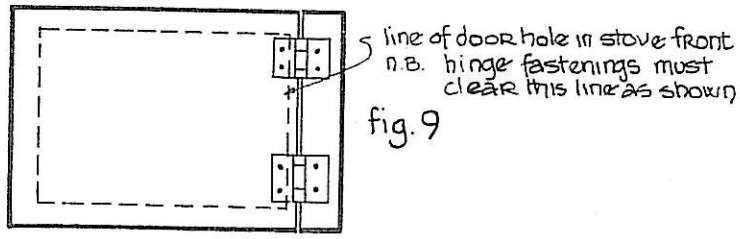


fig. 9

The bolts fixing a butt hinge to the door make it difficult to lap the side of the door over the door hole. The hinged edge must either come close to the edge of the opening or holes need drilling where the bolts protrude. Make sure the hinges will clear the door opening before fitting them.

Even though a bought hinge is every bit as good, there is a certain satisfaction in making your own, and they can look very neat. It is simple enough to do.

Take a 1½ inch strip of 16 gauge steel and bend the end around a nail in a vice. Round the end and drill a hole for a bolt.

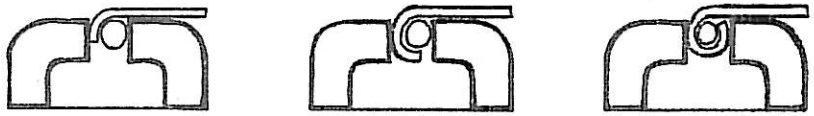


fig. 10

Cut a ¾ inch tab on the hinged edge of the door, 1½ inches wide, and bend it round a nail in the same way. Grind the head of the nail so that it is only just too big to drop through, and long enough to pass through both parts of the hinge.

Do the same for the other hinge, making sure that the two on the door line up with each other. and bolt them to the stove.

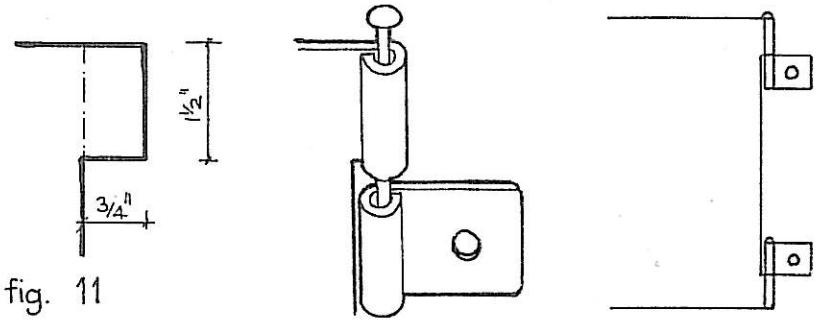


fig. 11

This method is appropriate for doors of between 18 gauge and 1/8 inch in thickness. Beyond that it is necessary to heat the steel with a blow torch to bend it, which is a little bit more difficult.

Flues

Position

In most stoves, a top flue would shorten the path of the fuel gases, which would slightly reduce efficiency. The eye tends to be drawn to a flue exit on the top of a stove, so a neat joint is important. The best place for a flue is out of the back of the stove, out of sight, especially if it is to be fitted into a bricked-up fireplace. A "hatchback" flue outlet gives the option for a vertical or horizontal flue whenever required. The back corner of the stove is made, and the bottom of the flue is cut, to a 45° angle. The flue can then be fitted either way round.

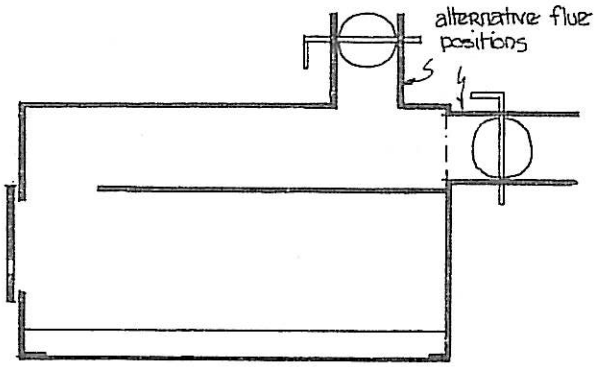


fig. 12

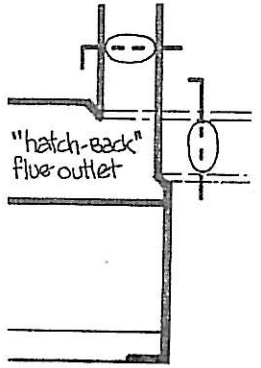


fig. 13

Size

The flue size is very important. A flue of between 4 and 6 inches diameter is adequate for a closed stove, depending on its size. But for one used with the doors open like an open fire, at least 7 and preferably 8 inches diameter is necessary. It is always better to have a flue too large, it can be adjusted with a damper.

Rectangular Flues

A square flue has virtually the same capacity as a round one of the same diameter in spite of having a larger cross-sectional area. This is because the smoke tends to move in a spiral. However, it is easier to make a short length of rectangular flue than a pipe, and easier to fit it.

For example, for a rectangular flue 6 inches by 5 and 18 inches long, take a piece of sheet steel 18 inches wide and 23 inches long. Bend it at 6, 5, 6 and 5 inch intervals into a rectangular tube. Tuck the spare one inch flange on the inside, smear with Gun Gum, and bolt or rivet the joint. (Gun Gum, sold as exhaust cement, makes a perfect seal on a seam.) The ends can then be cut and bent back as flaps for easy fixing. Alternatively, the hole into which it fits can

have flaps bent back and bolted to the flue – or you can do both. If it is to be fitted to a bricked-up chimney, a rectangular flue is easier to brick in than a round one.

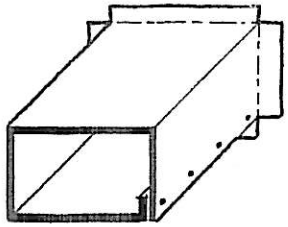


fig. 14

Fitting a Flue Pipe

Pipes are joined with one end fitting inside the next. It is important to fit each one inside the pipe below so that any creosote that condenses on the flue walls runs down into the stove and not down the outside of the flue. It is not as easy to fit a pipe into the top of a stove, but this is one method that works as long as the pipe is well supported.

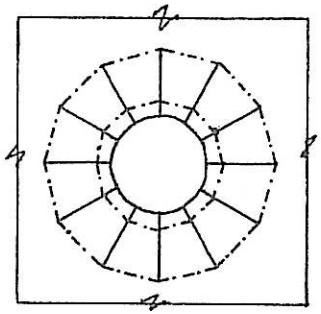


fig. 15

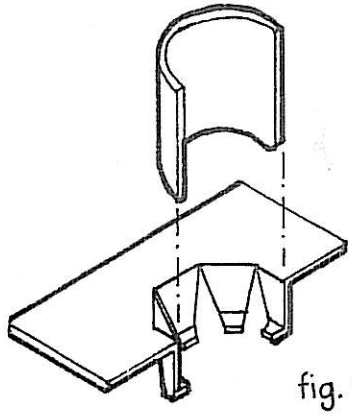


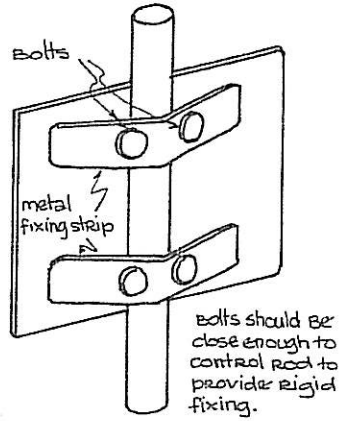
fig. 16

Scribe a circle where the pipe comes out of the stove, the same diameter as the pipe. (Note that for double-walled pipe the inner pipe fits into the stove and the outer one rests on top.) Scribe another circle within it 4 inches less in diameter, and cut out the smaller circle. Bend the tabs inward as shown. Smear the bottom of the pipe with Gun Gum and drop it onto the tabs. The same technique can be used to fit a pipe to the back or side of a stove, so long as its weight is well supported.

Dampers

It is often easiest to fit a damper in the flue just beyond the back of the stove. Drill holes through the centre of the pipe and push a rod through with one end bent over as a handle. Cut a flap to fit loosely inside the flue and weld or bolt it to the rod. In a vertical pipe, it may meed a spring between the pipe and the handle to hold it in whatever position is required. In a horizontal pipe this is usually unnecessary.

If the flue is not accessible at the back of the stove the damper control will have to be a longer rod coming right through to the front of the stove. In this case it is probably better to hinge the flap on a bar at the bottom of a rectangular outlet. There is a good example of a way of doing this in the description of the sheet steel combination stove.



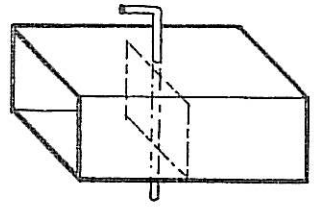
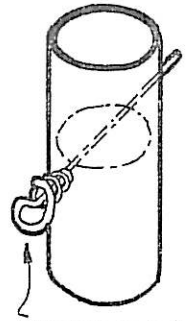


fig. 17



Concrete Bases

Reinforced concrete makes an excellent base for a stove. Cut a piece of plasterboard, plywood or hardboard to fit beneath the bottom flanges and line the inside with plastic sheet to stop the wet concrete running out. Use a fairly dry 5:2:1 mix of gravel to sand and cement. Bury lengths of fencing wire in a criss-cross fashion at least ½ inch below the surface and leave it for 4 or 5 days to harden before lighting a fire. The concrete should be poured to a depth of at least 2 inches.

Installation and Safety

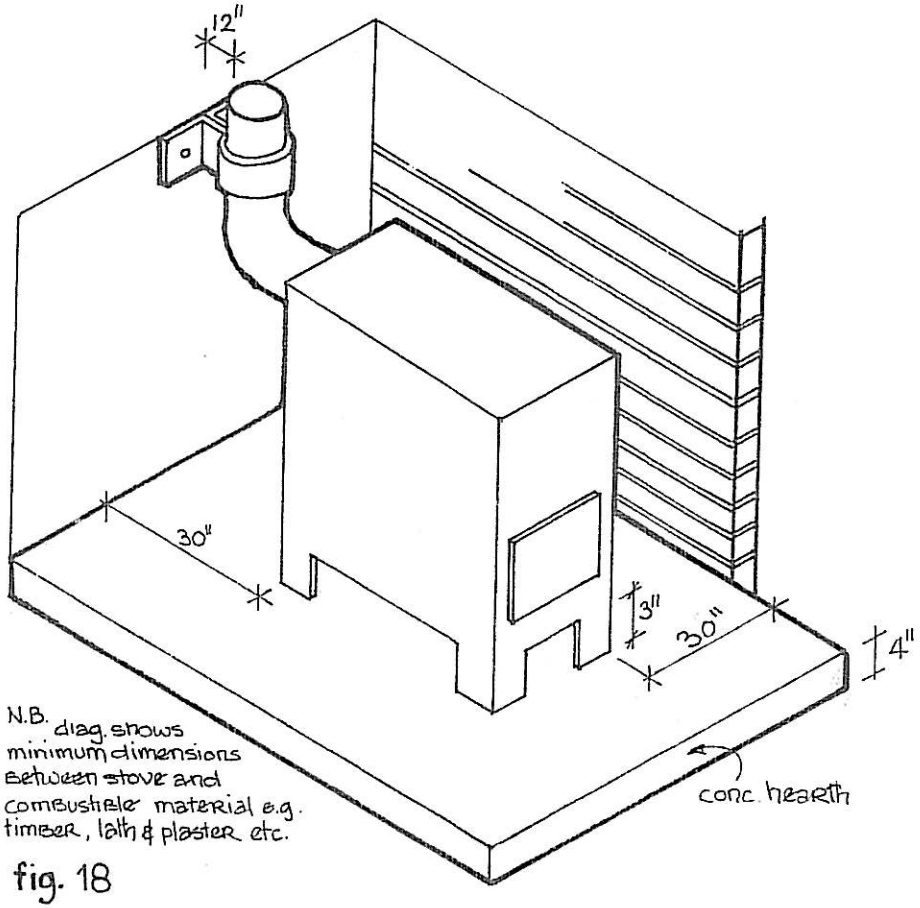


fig. 18

Installing a stove may take as long as building it, and should be considered before choosing a design. Any fire is potentially dangerous, especially if the chimney catches fire. British building regulations are not very adequate for wood stoves, so here, for guidance, are some American ones:

* No part of the stove should be less than 30 inches from any combustible material, such as wood or plaster and lath.

* It should be stood at least 3 inches above a hearth or concrete slab, which at that distance should be at least 4 inches thick. Otherwise it should be at least 12 inches above a sheet of non-combustible material such as steel or asbestos.

* No part of the flue should be closer than 12 inches to combustible material.

* The flue should be able to withstand a chimney fire, especially where it goes through a ceiling, roof or wall. Each length of pipe should be supported by a bracket capable of taking its weight, and joints should be sealed and held by two grub screws. Avoid horizontal runs of pipe, and use the minimum of bends.

* Never use asbestos pipe with a wood stove, because it will crack and fall apart with a chimney fire.

* The flue should be cleaned before installing the stove and adequate access provided for cleaning it at least twice a year. The whole installation should be checked for corrosion, cracks and signs of charring on neighbouring woodwork.

* If in doubt, consult your local fire safety officer through the fire brigade.

These safety requirements may seem severe, and with discretion can be reduced by perhaps a third. They are intended to protect against a stove the outside of which is glowing faintly red hot, which does happen, particularly along the side of a long box stove at full power. The back of a box stove is never as hot as the sides and top, and can usually be safely installed as close as 18 inches to an inflammable wall. There are also a number of ways of reducing the distances still further:

A double-skinned wall of a stove, with air circulating through the spaces, can be installed at half the quoted distances.

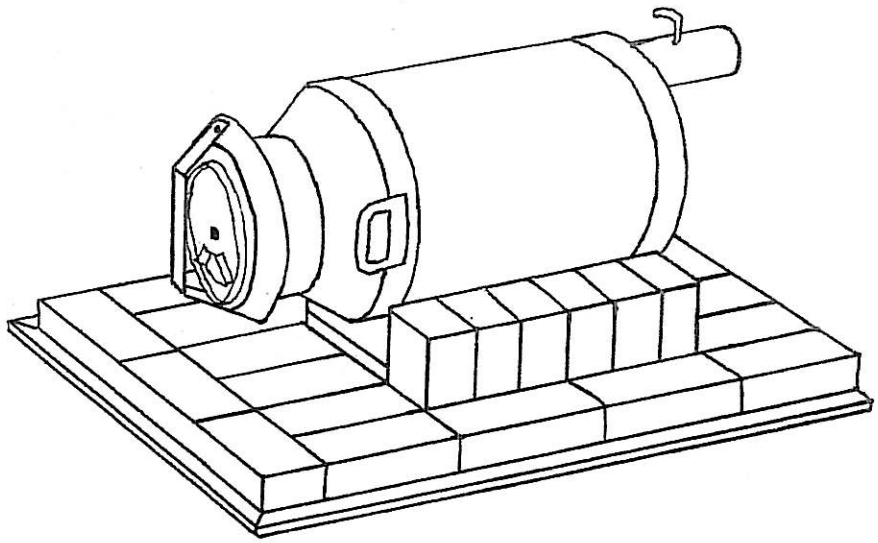
Combustible surfaces can be protected with a sheet of metal or asbestos wall board mounted one inch away from the wall on metal spacers. The stove can then be safely installed at half the quoted distances. In this way, a double-skinned stove can be positioned 9 inches away from a protected combustible wall.

The same applies to flues, so that an insulated flue can be mounted at half the distance from a combustible wall or ceiling, and if this too is protected, the flue can be as close as 4 or 5 inches.

It may be necessary to move a wooden fire surround and mantelpiece if it does not leave sufficient clearance around the stove, or else bring the stove further out into the room. The old fireplace is best bricked up, either leaving a soot door through which the chimney can be cleaned or making the stove easily removable to allow cleaning through the flue hole.

Otherwise a sheet of steel or asbestos can be fixed over the old fireplace, ensuring that no air can leak around the edges; it can be sealed with Gun Gum, fire clay or ordinary sand and cement. If the stove extends beyond the hearth, it is simple enough to cast a concrete base with a wooden surround mitred at the front corners.

Chortles



This is a very crude stove, but simple to build. The firebox is rather small, and the door is inconvenient for regular use. Nevertheless, it works well in a workshop or a room that is only occasionally heated.

Materials:

Old churn
4-6 inch diameter pipe
biscuit tin lid
nuts and bolts
fire cement or Gun Gum
large Jubilee clip or 22 gauge wire

Construction:

Scribe a circle the size of the pipe on the bottom of the churn close to one edge. Scribe a second circle within it one inch smaller all round. Cut out the smaller hole and make radial cuts at one inch intervals to the outer circle.

Bend the tabs outwards and slide the pipe through so that it comes 12 inches from the open end of the churn.

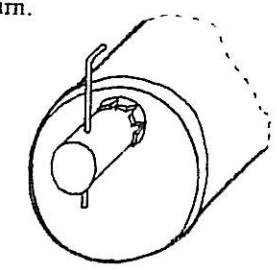


fig. 19

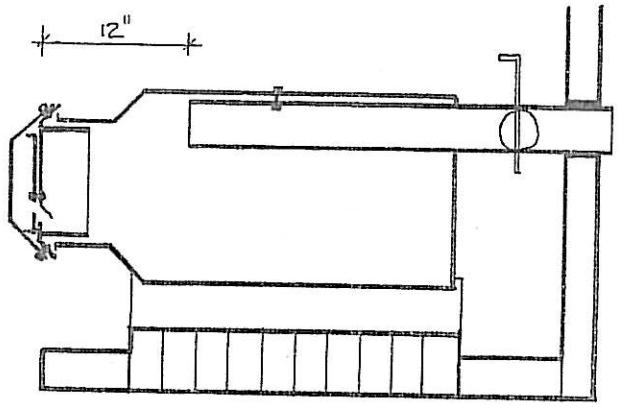


fig. 20

Smear the joint where the pipe comes through with fire cement or Gun Gum and bind it with a large Jubilee clip or 22 gauge wire.

Cut a flap in the churn lid and bend it inwards. Cut a matching hole in the biscuit tin lid, with tabs bent over at both sides. Bolt the tin lid to the centre of the churn lid, so that it will turn to hit or miss the air vent in the churn lid.

Bend a strip of thick steel (1/8 inch will do) to make a handle and bolt it to the top and bottom of the churn lid.

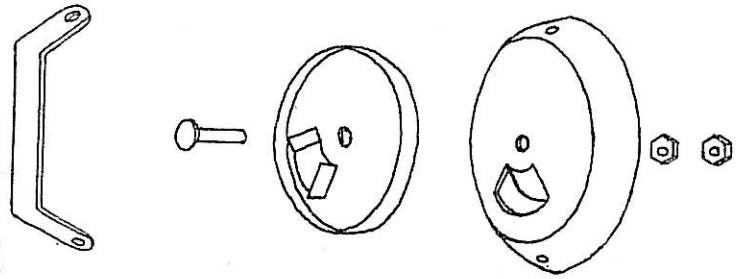


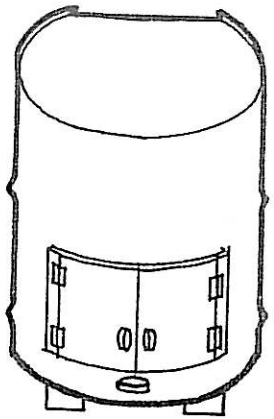
fig. 21

Fit a damper in the flue pipe (see "Dampers" section). There are various ways of fitting legs, the simplest of which is a line of bricks, as illustrated.

The best way of lighting this or any long stove is to burn a load of old paper at the back, while laying a small fire of paper and kindling at the front. The blazing fire encourages a good draw.

Do not worry about the solder running from every joint! It was there to make the churn water-tight, not to hold it together. Ventilate the room thoroughly during the first few firings to get rid of the fumes from the solder.

Oil Drum Combination Stove



This makes a very elegant stove combining the benefits of an open fire with the relative efficiency of a closed stove, and it is cunningly designed so that all the metal required comes out of one oil drum. It will not, however, burn so slowly or stay alight so long as a box stove.

It is designed to stand flush against a fireplace, and the dimensions of the back may need adapting if it does not fit yours. Otherwise it could have a flue pipe or rectangular flue fitted (see "Flue" section).

Materials:

45 gallon oil drum
4 small cupboard hinges
nuts and bolts
short length 1½ inch iron pipe
¼ inch steel bar
concrete mix
Gun Gum

Construction:

Cut off the flat circular bottom of the drum just inside the rim. Turn the drum upside down and light a bonfire in it to burn off the paint.

Cut off the bottom section of the drum just below the bottom ridge. This will be used to make the doors.

Back:

Cut the back off the drum to leave a 12 inch wide hole all the way down, removing the rim at the top but leaving the circular disc of the top intact.

Bend 2 inch flanges down both sides of the hole (inwards) to form a flat surface 16 inches wide for the back of the stove. Bend the circular top down flush with it. The ridges will need flattening with a hammer where they meet the back.

Before cutting up the discarded bottom and back parts, mark out the bits you will need.

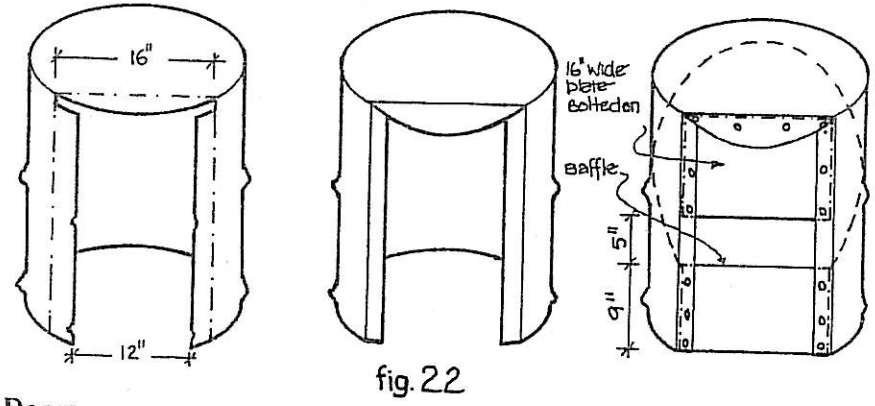


fig. 22

Doors

Cut the door hole 7 inches deep and 14 inches wide, about 2 inches below the top ridge. Without losing the natural curve of the metal, cut the doors in one piece, 16½ inches wide and 9 inches deep, from the discarded bottom section. Cut 1 inch strips off each side to go as spacers under the hinges. Cut the door piece in half to make double doors, butt them and bolt them in position with the spacers and hinges, overlapping the door hole by 1 inch top and bottom.

You could make your own hinges (see "Hinges" in "Door Details" section) in which case the doors can overlap at the sides as well, and need cutting longer.

Baffle

Mark a diagonal line round the curve of the stove, on the inside, from 9 inches above the bottom at the back to 5 inches from the top at the front. This is where the baffle will fit. Make a template out of thick card for an accurate fit, and extend it to bend down the back of the stove to the bottom edge, to fit inside against the 2 inch flanges.

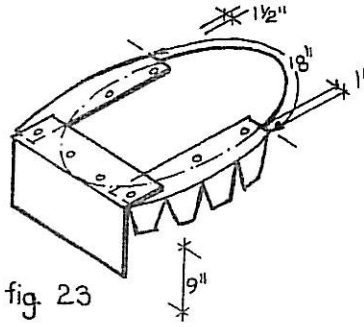


fig. 23

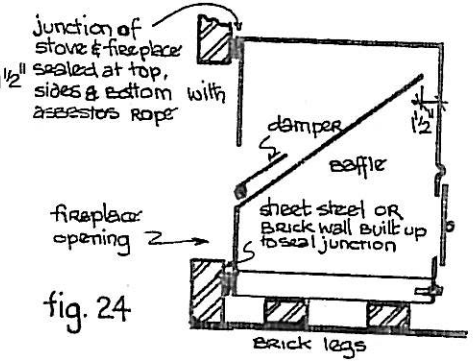


fig. 24

Stop the baffle short 1½ inches from the front at the top, leaving a 1½ inch throat curving round the front 18 inches of the stove.

Make the baffle from the flat bottom of the drum, extending it down the back and to make 1 inch flanges along the sides with other metal from the discarded bottom section. Smear the joints with Gun Gum and bolt into position.

Cut another piece to cover the top of the back of the stove, to leave a 5 inch gap above the baffle for the flue. Fix this inside the 2 inch flanges of the back, with the flat circular top bending over onto it.

Damper

Cut a damper to cover the flue hole, with 1½ inch overlap all round. Drill tight holes through the sides of the drum close to the bottom of the flue opening. Bend one end of the bar as a handle and put it into position. Bolt or weld the damper bar in situ so that the bent end of the bar can be moved to open and close the damper.

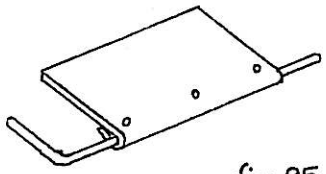


fig. 25

N.B if the rod is too thin for bolting through, bend the sheet around it and clamp it on.

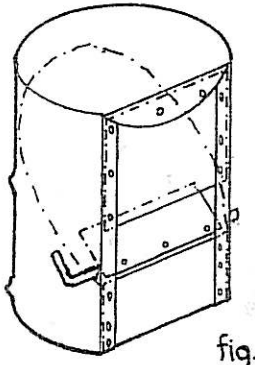


fig. 26

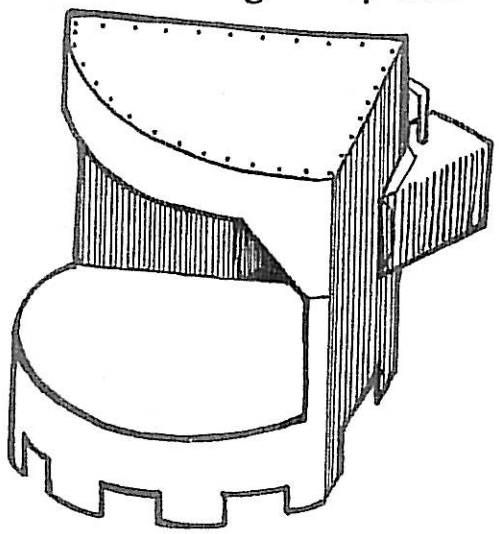
Door Handles and Catches

Cut three ½ inch lengths of 1½ inch iron pipe to make rings. Cut through the rings at one point so that heat can only be conducted around one way, and bolt one to each door as handles. Bolt the other one immediately below the doors where they butt together when closed, so that with the rings vertical the doors are held closed, and when horizontal there is room for the doors to swing open. A spring washer on the fixing bolt tensions the catch and keeps the doors tight shut. Alternatively, make a catch and latch as described in "Catches and Handles" in "Door Details"section.

Base

Cast a 2 inch concrete base in the bottom, held in position by 2 inch bolts through the bottom ridge. Improvise 4 inch legs and sit it in the hearth, butted up against the fireplace. A good seal at the back is essential, so either bolt it in position with tabs or pack the gap with asbestos rope. Polish the stove with Zebrite grate polish. (see fig 24)

Woodburning Fireplace



Materials:

16 gauge sheet steel
nuts and bolts
concrete

Construction

Cut a sheet of 16 gauge steel to 48x33 inches. Fold it down the middle to 90°. If you are unable to make the fold, use two sheets 25x33 inches and join them at the back with overlapping flanges.

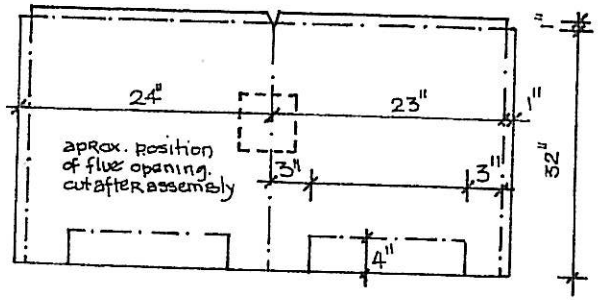


fig. 27

Turn a 1 inch flange forwards along the top, and a 1 inch flange inwards at the two ends, all at right angles to the sheet.

At 3 inches from the back and 3 inches from the front ends, make 4 inch deep cuts for the legs. Fold the 17x4 inch flange between the legs forward, to support the concrete.

Cut a piece for the hood 38x16 inches. Turn a 1¼ inch flange at each end. Make triangular nicks 1 inch deep every 3 inches along the top, and turn the resultant 1 inch tabs over. Make a 6 inch deep cut at a 45° angle in from the flanges at the ends and cut out the 6 inch wide strip of metal between them, to give the shape of the hood.

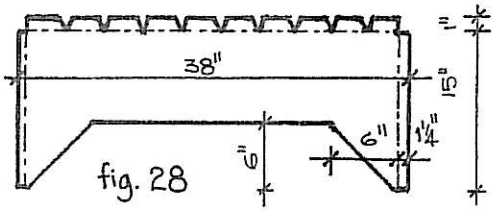


fig. 28

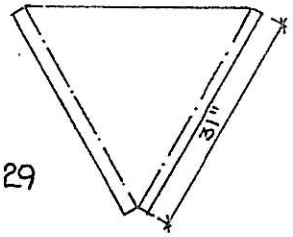


fig. 29

Cut an equilateral triangle for the baffle 31x31x31 inches plus 1½ inch flanges down the two sides. Bend the flanges to just under 45°.

Fit the triangular baffle to leave a 1½ inch gap between it and the top of the stove, making a 1½ inch deep throat across the whole width of the stove. This 1½ inch distance is an important dimension. Bolt the baffle into place.

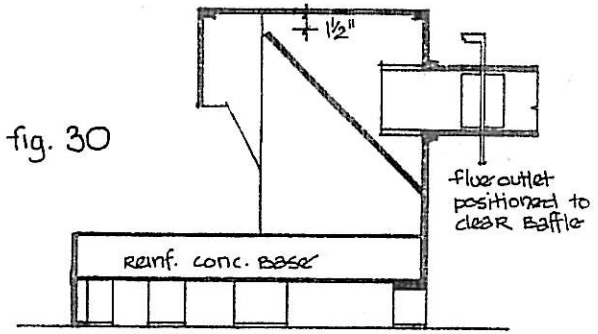


fig. 30

On the sides of the stove measure in 5 2/3 inches from the back, and mark it just above the baffle. From this point up mark a vertical line 8 inches long, then horizontal lines from each end of this to the back corner of the stove. Extend these lines round to the other side and mark another vertical of 5 2/3 inches. Cut out a hole for the flue 1 inch in from these lines. Make diagonal cuts in the corners and bend out the 1 inch flanges, to take the 8 inch square flue. (see fig 31)

Fold a square section flue from a piece of 16 gauge as long as you require the pipe to be and 33 inches wide. This gives an 8 inch square flue with a 1 inch flange overlap.

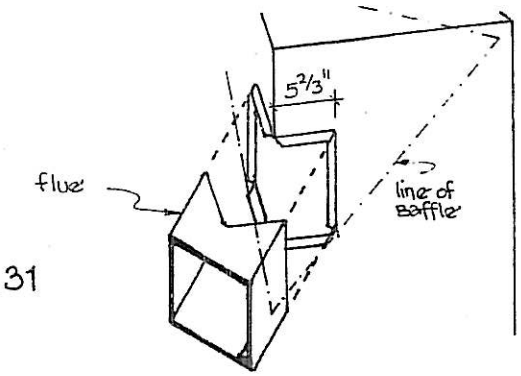


fig. 31

Bolt the flue together and cut 90° triangular nicks in the top and bottom to match the shape of the back of the stove. Smear the joint with Gun Gum and bolt it to the flanges of the flue opening.

Flex the hood into a curve and bolt the two side flanges to the front of the sides of the stove.

Cut the top to fit. Smear the joint with Gun Gum and bolt it into position.

Cut a 5 foot strip of 16 gauge for the front of the hearth. Cut 5 inches into it at 6 inch intervals along its length. Fold back alternate flaps to support the concrete hearth, leaving 5 inch legs. Make triangular nicks in the middle of each leg to a depth of 1 inch and bend the bottom inch of each leg inwards to make feet. Bolt the ends to the bottom of the stove to enclose a space in which to cast the hearth.

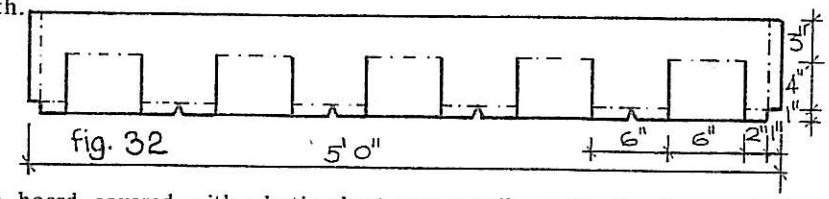


fig. 32

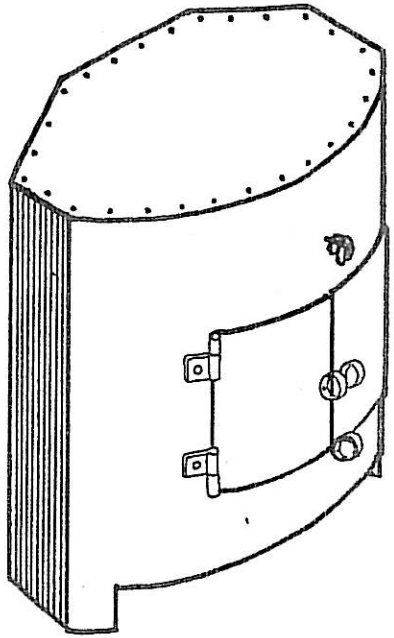
Fit a board covered with plastic sheet temporarily under the flanges at the bottom of the stove, and cast a 3 inch concrete hearth with plenty of wire or other lengths of metal for reinforcement.

Fit a damper inside the square flue rotating on a vertical axis on a rod that extends through the bottom of the flue, bent over to form a handle. In use, the damper will normally be almost fully open. It is there primarily as a safety precaution, since the best way to extinguish a chimney fire is to close the damper and stop the draught. Better still, clean all chimneys twice a year.

Install the stove so there is no air leak between it and the flue or fireplace it fits into. All joints should be smeared with Gun Gum.

Avoid lighting huge bonfires in it. The large hearth enables long logs to be burnt but if the blaze is allowed to creep further forward than the hood, the fire will smoke into the room.

Sheet Steel Combination Stove



Description

This stove is derived from the Woodburning Fireplace, adapting it to make a combination stove. It is designed either to fit flush against a fireplace or to take an 8 inch square flue. A flush fit means it will usually sit within the existing hearth, saving the need for a concrete base, although the dimensions of the stove may have to be altered to fit your fireplace.

The curved front allows for expansion, removing the need for complicated door seals. Sufficient air will leak in around the doors to keep it burning slowly without an extra air vent, and for faster burning the doors can be left slightly open.

Materials

16 gauge sheet steel
5/16 inch rod 3 feet 6 inches long
short length 1½ inch iron pipe
nuts and bolts Gun Gum concrete mix

Construction

Cut a sheet 72x29 inches and take nicks out of it for 1 inch flanges along the top and 5 inch flanges between the legs along the bottom. The diagram shows cuts as solid lines and folds as dotted lines. The flue flanges are bent outwards, all the rest are bent inwards.

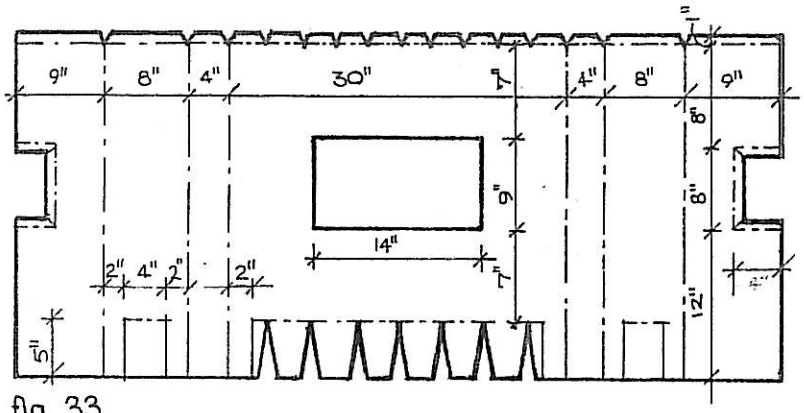


fig. 33

Make a large scale drawing of the stove as seen from above so as to determine the angles to which each of the main folds should be made. These folds will have to be done on a folding press or a home made jig of strong angle iron. If you are unable to do this and cannot get it folded for you by a blacksmith, make the same shape with one piece for the front flanged round the sides, another two for the sides flanged to meet the front and back, and a fourth single piece for the back, flanged to meet the sides. Bolt it all together, with Gun Gum for a perfect seal. (see fig 35)

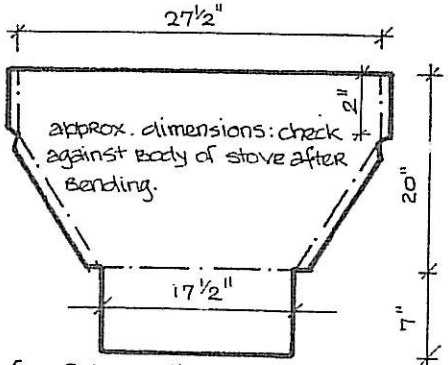


fig. 34 pattern for baffle

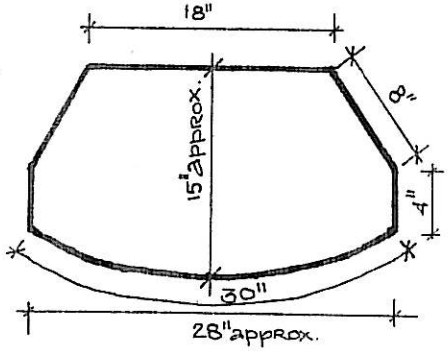


fig. 35 Bending plan

Having made the six main folds to the correct angles mark the hole for the flue, 4 inches deep and 8 inches high, on each side of the back, starting 12 inches from the bottom of the stove. Cut out a hole 1 inch in from these to leave 1 inch flanges. Bend these outwards.

Bend over all the 1 inch flanges along the top of the stove. Then bend the flaps between the legs at the bottom, leaving 5 inch legs.

Clamp the stove into shape with the front curved and the two halves of the back butted together, so that the 4 inch sides are parallel. Use either sash cramps, or jam it between two heavy workbenches. Then check the actual dimensions of the baffle before cutting and folding it as shown in the diagram. Make it ¼ inch narrower than the stove, and any slack will be taken up in fitting. (see fig 34)

Bolt the baffle into position from ½ inch below the flue opening at the back to 1½ inches from the top at the front. The stove should then more or less hold its own shape without clamps.

There is a butt joint at the back of the stove where the two ends of the sheet meet. Below the flue this joint is covered by the baffle, which extends into the concrete base. If the stove fits flush against a fireplace this may not matter. Otherwise, cover the 8 inches above the flue with a strip of metal, sealed with Gun Gum and bolted or riveted into position.

Cut the door opening 9x 14 inches as shown in the cutting plan.

If the stove is going to have a rectangular flue pipe, the damper is much easier to make. Fit a vertical axis damper in the flue pipe as described in the "Dampers" section, and extend the control bar to the top of the stove if access to it would otherwise be difficult.

If the stove is intended to fit flush against a fireplace you could make a damper like the one in the oil drum combination stove. Strips bent at right angles would have to be fixed to the back to stop the damper sliding out sideways.

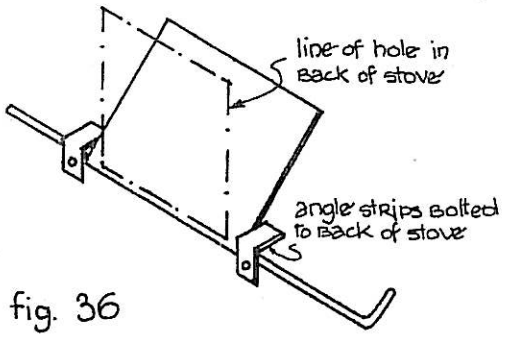


fig. 36

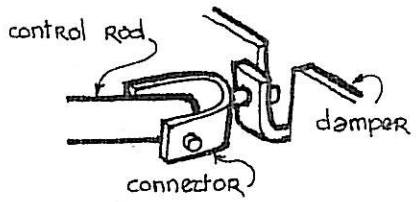


fig. 37

Another way is to make the control rod come to the front of the stove. To do this make the following:

Cut a plate for the damper 10 inches square. Make two cuts about 1 inch apart, 1½ inches deep, in the middle of one of the sides. Drill a hole in the centre of this strip for the bolt from the connector. Then bend the strip into a semi-circle out from the damper. (see fig 37)

Make the connector by bending a strip of metal about 2½ inches long and ¾ inch wide into a U shape round a bar. Drill a hole in the bottom to take a bolt, and drill holes through the ends to take a 2 inch, round nail or something similar. Bolt the connector to the damper.

Make two hinges for the damper by bending a small piece of sheet steel at right angles, drilling a 5/16 inch hole in one side and a bolt hole in the other. Bolt these to the back, close to the baffle and far enough apart to take the damper. Insert the 5/16 inch bar and weld or bolt the damper to it, in situ.

Before fitting the damper control rod, make a handle on the end of it. You could do this with a ring, but a spiral is elegant and simple to make.

Fix the 5/16 inch rod in the vice with 15 inches of rod poking up through the jaws. Heat the rod with a blow torch and bend it first to a sharp right angle. Then wind it into a tight coil, keeping it red hot. Cool it in a bucket of water and put it back in the vice with the coil 3 inches above the jaws. Tuck the end in towards the middle and below the coil, and cut it off.

Now heat the whole coil to red hot again and push it against the slightly opened jaws of the vice so that the centre of the coil opens down between the jaws. Tidy it up by adjusting the coils of the spiral with a lever and a pair of pliers until you have a neat spiral.

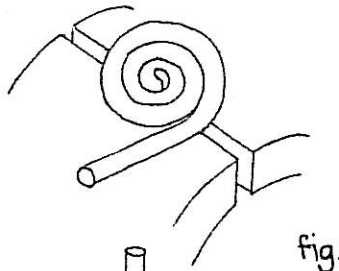


fig. 38

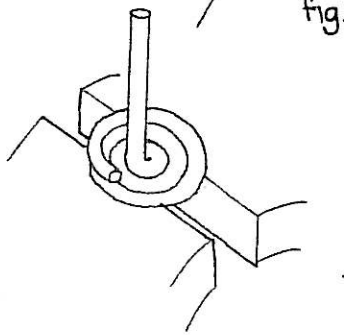


fig. 39

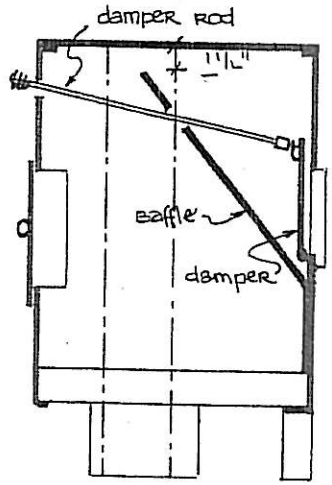


fig. 40 damper control in closed position

Drill a 5/16 inch hole in the middle of the front of the stove, four inches below the top. Mark on the baffle where the hole lines up with the connector on the damper and drill or cut a 1 inch hole. Push the damper control rod through and cut to length. Drill a hole at the end to take the nail or pin from the connector. Put the nail through both and then check if the rod will open and close the damper without getting caught in the baffle. If necessary enlarge the baffle hole with a file.

If the damper will not stay in position, file notches on the rod to catch on the front of the stove where it comes through. Bend over the nail or pin to stop it coming out. (see fig 40)

Cut the doors in one piece of 16 gauge 18x11 inches. Curve it through a mangle or by beating it over the spare wheel of a car until it is the same curve as the front of the stove. It is worth taking some trouble over this to get a reasonable door seal.

Decide whether to fit butt hinges on the doors or to make your own (see under "Hinges" in "Door Details" section). If you decide to use butt hinges, cut a ¾ inch strip off each side of the single door piece to use underneath the hinges

Bolt the door over the opening with a one inch overlap top and bottom. Remove it again and cut it in two down the middle to form two doors, then refit.

Fit handles to each door, and a door catch as described under "Catches and Handles" in the "Door Details" section. A catch and latch handle is the most effective, though a ring that swivels to trap the doors in the middle, top and bottom, is adequate and a lot simpler.

Fit a board beneath the legs up against the bottom flanges and cast a 2 inch concrete base reinforced with fencing wire or any old bits of metal, none of which should be less than ½ inch from the surface.

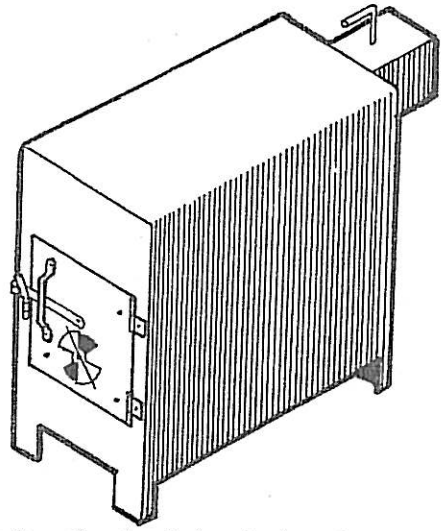
Cut a top to the stove, to fit either flush or with ½ inch overlap round the front and sides. Gun Gum the top flanges and bolt or pop rivet it on.

Make the rectangular flue if required from sheet steel 33 inches wide and as long as required. This gives an 8 inch square flue with 1 inch flange overlap. If the damper is to be in the flue pipe make it in situ (see "Dampers" section). Smear the joint with Gun Gum and bolt through to the flanges on the back of the stove.

When fitting flush, this stove can be butted up against a fireplace with a flat front, jamming a length of asbestos rope to seal the joint. Alternatively it can be butted up to a bricked up fireplace with a flue hole or to a fireplace blocked with a sheet of metal.

Polish the stove with Zebrite every month or so.

Steel Box Stove



This stove, based on a Scandinavian design, is virtually air tight and should stay alight overnight if loaded with suitable wood. The construction is simple in sheet steel, or it could be made from a suitable cold water storage tank, with the open top becoming the base sealed by the concrete bottom. This one is 23 inches high 12 inches wide and 24 inches long but the size could be adapted for a stove of between 12 and 30 inches long. It has a maximum heat output of about 5 kilowatts.

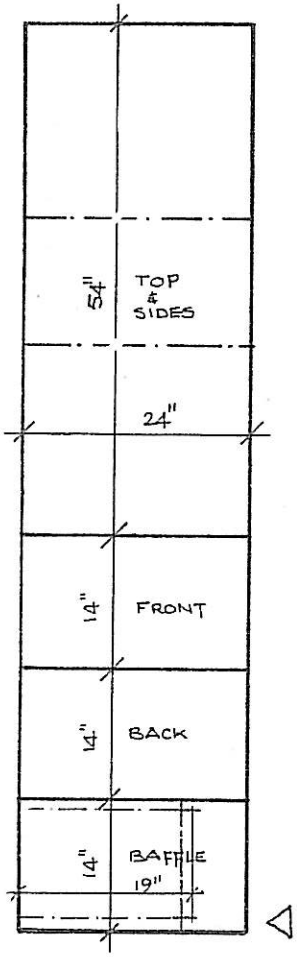
Materials

16 gauge sheet steel, 2 feet by 8 feet for stove body and baffle
16 gauge sheet steel 8x8½ inches for air inlet baffle
16 gauge sheet steel 10x10¾ inches for door
various small pieces of 16 gauge for hinges and catches
nuts and bolts or rivets
small spring for air inlet control (about 5 lb pressure)
concrete mix Gun Gum Zebrite

Cutting and Folding

The baffle and the front and back with their door and flue openings are made first, and the top and sides fitted to them. Think ahead about how to make each fold. The best sequence will depend on the tools you are using. Most probably the cuts should all be made first, and the top and side flanges folded before the flue or door hole flanges. (see fig 41,42)

Mark out the door opening as shown. Lines show cuts, dotted lines indicate a fold.



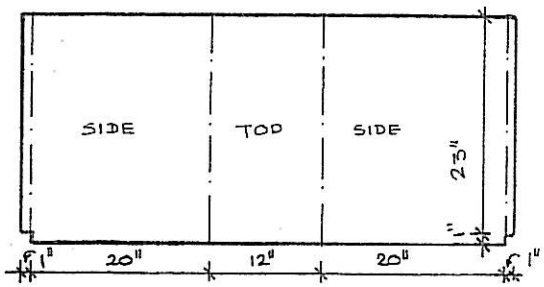


fig. 43

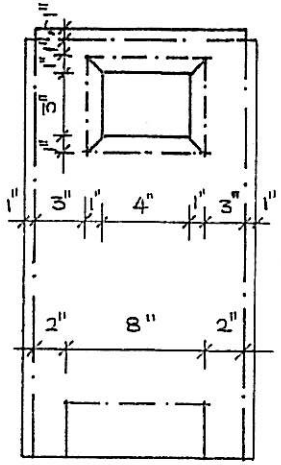
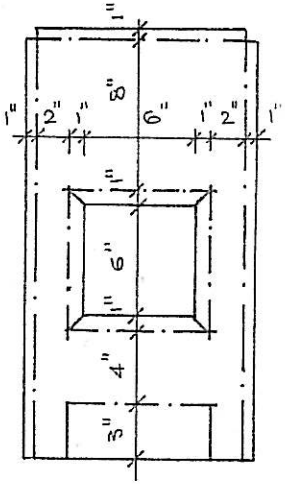


fig. 42 Back



front

◁ fig. 41 cutting plan for 8' x 2' sheet

Cut the door opening 6x6 inches as shown and bend back the flaps, leaving a door hole 8 inches square. (see section on "Doors") Be careful not to distort the metal around the door in this process.

Fold back the flap between the two front legs to support the concrete base.

A 5 inch diameter flue, or a 5x6 inch rectangular one, is suitable for this stove.. The flue should be fitted either at the top of the back or at the back end of the stove top. If you would like it to be interchangeable, this stove can easily be adapted to be a hatchback. See section on "Flues" for this and for standard fitting instructions.

The back of the stove is made in the same way as the front, with a flue hole if required.

Measure the exact external dimensions of the front and back of the stove before folding the top and sides. If you are having these folds done beforehand at the blacksmiths, take extra care in folding the flanges on the front and back sections. Cut out the 1 inch nicks at each corner for the legs. Fold a 1 inch flange along each end, and the two folds about 12 inches apart in the middle. Bolt or rivet the top onto the stove before the sides.

Cut the sheet for the baffle 19 inches long and nick out two corners at one end, and fold 1 inch flanges along the sides and back. (see fig 41)

Assembly

Smear Gun Gum on the flanges of the front and back sections and fit the top over them, with rivets or bolts at 3 inch intervals.

Bolt or rivet the baffle to the sides and back so that it comes just below the flue outlet and runs parallel to the top of the stove. (see fig 44)

Clean off any spare Gun Gum squeezed out of the joints with a knife.

Make a door, as described in the section on "Door Details" and fit a damper as described in the "Dampers" section. Cast a 2 inch base, as described in the section on "Concrete Bases".

Polish the stove with Zebrite every month or so. Note that Zebrite will not stay on galvanised steel because the zinc tends to oxidise and bubble off.

Larger versions of this stove should have side baffles hanging from the fixings for the horizontal baffle, spaced ¼ to ½ inch from the side walls. These are to stop the side walls from overheating. (see fig 45)

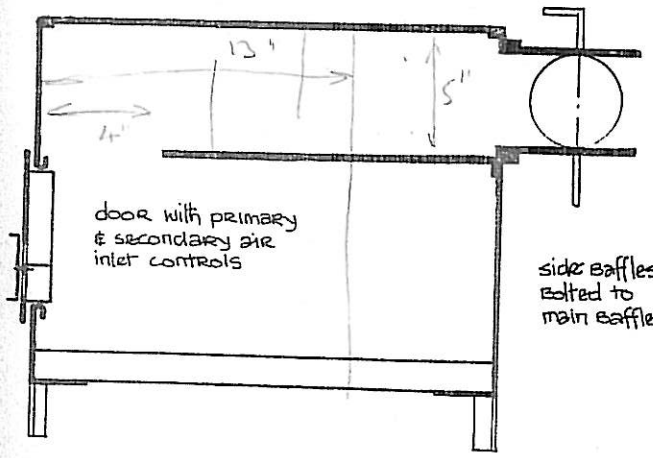


fig. 44

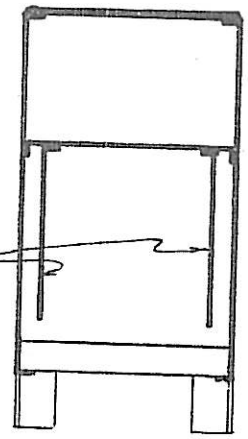


fig. 45

Other Possibilities

Two types of stove have been described in detail in this booklet: the box stove with a horizontal baffle and the open fronted, or combination, stove with a sloping baffle. A variety of stoves can be built with these baffle systems, from oil drums, water tanks, churns or sheet steel containers of almost any shape. For instance, doors could be put in the largest surface of a water tank opposite a sloping baffle to make a combination stove, or an oil drum could be laid on its side with a horizontal baffle.

Back boilers can be fitted at the point where the flames lick round the edge of the baffle on their way to the flue.

Here are some examples of other baffle systems:

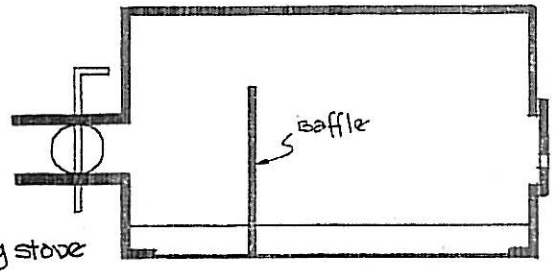


fig.46 cooking stove

The top of this stove is very hot, which makes it a good design for a cooking stove, though the flue gases do not meet the air vent very well.

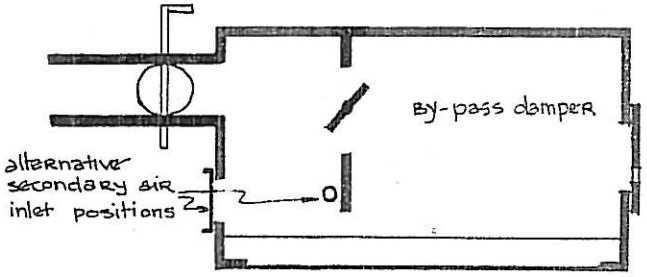


fig.47

This is a simple cross-draught stove. The flue gases have to pass the hottest part of the fire on their way to the flue. The bypass damper is opened when lighting or refuelling. The best place for the secondary air inlet is a pipe with holes drilled in it immediately behind the bottom of the baffle. More sophisticated versions have a bi-metal coil in the flue which automatically adjusts the secondary air inlet.

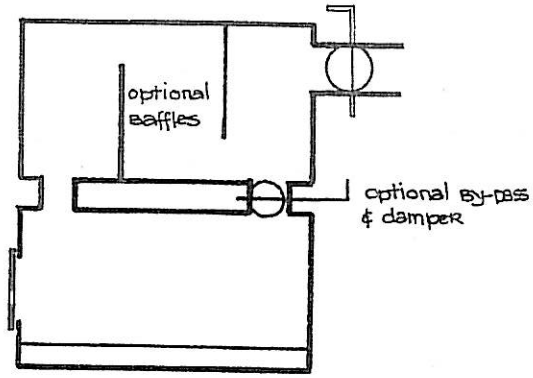


fig. 48 high-output stove suitable for large workshops

Two oil drums, churns or tanks can be mounted one on top of the other for a stove with very high heat output. Enlarging the chamber above the baffle is a good way of increasing heat output, forcing the smoke around the baffles to take a longer path to the flue. The longer the path the harder it is to light, so by-pass dampers are sometimes necessary. A flue with a good draw is essential.

Wood stoves are often built with hot air convection by fitting a second skin through which air circulates. This encourages a good air circulation in the room, distributing the heat. It also regulates the temperature of the stove's surface, making the installation safer for children and reducing the fire hazard. The outer skin can be of thinner metal, such as 18 gauge steel, and the stove within very crudely finished.

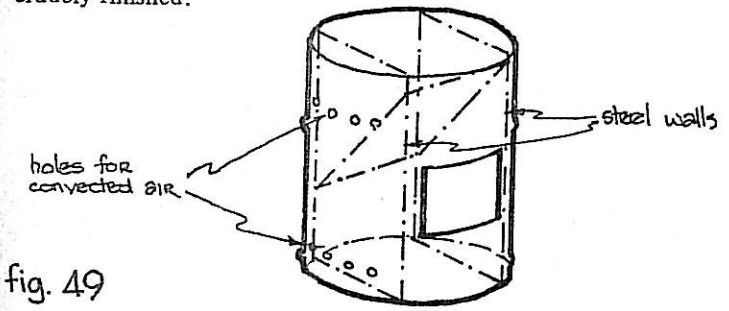


fig. 49

It is actually easier to build the oil drum combination stove with side walls enclosing a cavity on each side through which air is convected. The firebox is then almost square, which makes the baffle easier to fit; and the baffle and side walls can be made in 16 gauge and be inserted already bolted together. The sheet steel combination stove can also be converted in this way.

Having understood the basic principles and the techniques for sealing seams, endless possibilities for improvisation are open to you. Also, home-made versions can be adapted from most commercially available stoves.

Metal Working

Marking Out

Mark out the lines for cutting and folding a sheet of steel by scoring with a scribe. The sharpened end of an old file, or any other piece of tool steel will do. Go over the score with a felt tip pen to make it clearer if necessary.

A new sheet of steel has machine cut edges which are square and straight. Your cut pieces will not be, and may be slightly over- or under-sized. So score a centre line down each one and mark out by measuring off from it.

Cutting and Drilling

Sheet steel comes in two main sizes: 4x8 feet and 3x6 feet. It is available from blacksmiths, agricultural engineers or sheet metal works as well as metal wholesalers. Sixteen gauge is the heaviest most of us can handle in a home workshop, and anything less than 18 gauge is too thin for a stove. At 1979 prices, 16 gauge costs £12 for a 4x8 feet sheet; steel for the steel box stove would therefore cost about £6.

Most other materials can be bought at a hardware shop.

When buying the sheet, it is advisable to have the main pieces you require cut on a guillotine. Otherwise it is possible to do these cuts with an abrasive disc that fits a circular saw. There is also a rectangular-toothed circular saw sold for cutting corrugated iron that will handle up to 16 gauge steel, but it is extremely noisy (wear ear muffs or earphones) and sends chips of steel flying everywhere (goggles and face protection).

For shorter cuts use a hacksaw. Sometimes it is not possible to get the hacksaw at the cut. The crudest alternative is to place the sheet on a solid metal surface such as an anvil and cut it with hammer blows on a sharp chisel. Keep working along the line of the cut until it goes through. Otherwise file along the cut with an Abrafile (a thin flexible file) or a hacksaw blade held at both ends in padsaw handles. There are flexible hacksaw blades that do not shatter so easily. The ideal answer for these interior cuts is a jigsaw with a metal-cutting blade. This should be operated at the lowest possible speed, and the blade should be cooled with cooling fluid or, failing that, with oil. Jigsaws and Abrafiles can also be used to cut curves; otherwise an external curve can be roughed out with straight cuts and filed smooth with a flat file or grinding wheel.

Before drilling a hole, dent it with a centre punch to prevent the drill bit slipping off centre. Always drill at the slowest speed, with plenty of pressure, otherwise the drill bit will overheat and blunt. Drill small pilot holes before using a large drill. Use "High Speed Steel" drills. A masonry bit will cut through cast iron. If you can't sharpen drill bits yourself, you can usually get them done at a hardware shop.

Folding and Bending

For long folds, get the blacksmith to do them on a folding press. Failing that, clamp the sheet between two heavy angle-irons and hammer it gradually flat as you ease it over. Flanges can be bent with a portable vice: clamp the vice onto the flange and bend it over. Longer flanges can be cut so that 4 inches are bent over at a time. If possible, clamp the sheet, just behind the flange, between two lengths of angle iron.

Fixings

Seams generally need fixing at 3 inch intervals.

Riveting leaves less head exposed than a bolt, and is cheaper; it is not difficult if the sheets can be laid on a solid iron surface. Large steel "pop" rivets (3/16 inch) are very convenient, although the cheaper riveting pliers will not handle them. Alloy rivets are liable to get too soft.

The heads of bolts can be ground almost flat where a flush surface is required, using a file.

Electric arc or gas welding opens up many more possibilities, though it tends to burn and distort sheet metal. As good a seal can be made with Holt's Gun Gum smeared on a bolted or riveted flange.

Recommended Reading

For anyone seriously interested in wood stoves this short booklet inevitably raises as many questions as it answers. There are very few British publications on the subject, but some American ones have lately appeared in the shops.

– "The Woodburner's Encyclopaedia" by Tony Sheldon gives detailed scientific and technical information on woodburning stoves, all referred back to the original research papers.

– "Woodstoves – How to Make and Use Them" by Ole Wik is very sympathetically written by someone who obviously knows his subject and has a great deal of useful experience in it. It is excellent on building stoves from oil drums.

– "Wood Heat" by Vernon is a bigger and glossier book, starting from the comforting assumption that the reader knows nothing. Much of it is common sense and it always stops short of going into depth on any topic, though its sections on fireplace design are the best anywhere.